Interferometric Analysis of Peculiar Stars with the B[e] Phenomenon

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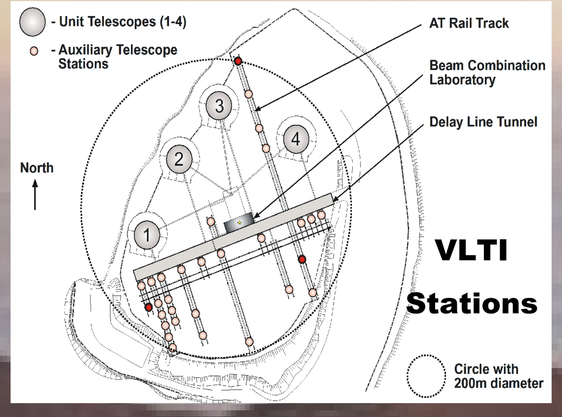
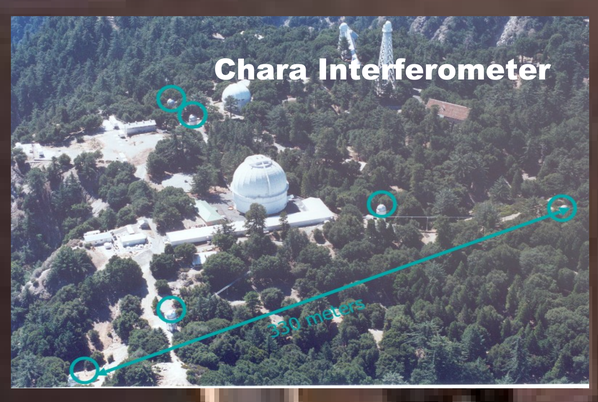
Abstract: ***Stars*** **that present the B[e] phenomenon are known to form a very heterogeneous group. This group is composed by objects in different evolutionary stages, like high- and low-mass evolved stars, intermediate-mass pre-main sequence stars and symbiotic objects. However, more than 50% of the confirmed B[e] stars have an evolutionary stage still unknown, being called as unclassified B[e] stars. The main problem for these stars is caused by the absence of reliable physical parameters and knowledge of their circumstellar geometries. Based on this, high-angular resolution interferometry is certainly an important tool to answer several questions concerning the nature of these stars, including a possible evolutionary link between B[e] supergiants and LBV stars, like Eta Car. In this work, we present the results related to a sample of objects, based on observations using VLTI/MIDI, VLTI/AMBER and CHARA/VEGA.**

B[e] Phenomenon and Interferometry





The B[e] phenomenon was defined by the presence in the optical spectra of B-type stars (Conti, 1997, ASP Conf. Ser. Vol. 120, 161) of:

(a) Strong Balmer emission lines;

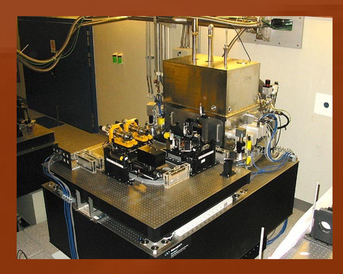
(b) Permitted emission lines of mainly low ionization metals, e.g. FeII;

(c) Forbidden emission lines of [FeII] and [OI];

and also a strong near or mid-infrared excess due to hot circumstellar dust.

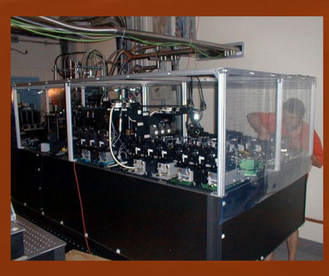
Recently the optical/IR long baseline interferometry, especially with the VLTI and CHARA, has become an important tool to deeply study the circumstellar environment of the brightest B[e] stars. Thanks to the field of view and the high spatial resolution of instruments, like AMBER, MIDI and VEGA, it is possible to have access to information related to circumstellar medium close to the stars, allowing us to obtain sizes, shapes, and orientations, as a function of wavelength in the optical, near and mid-IR ranges.

MIDI



Mid-IR (8-13μm)
2 telescopes
Visibility and differential phase
R=30, 230
θ_{min}=10mas, beam=300mas

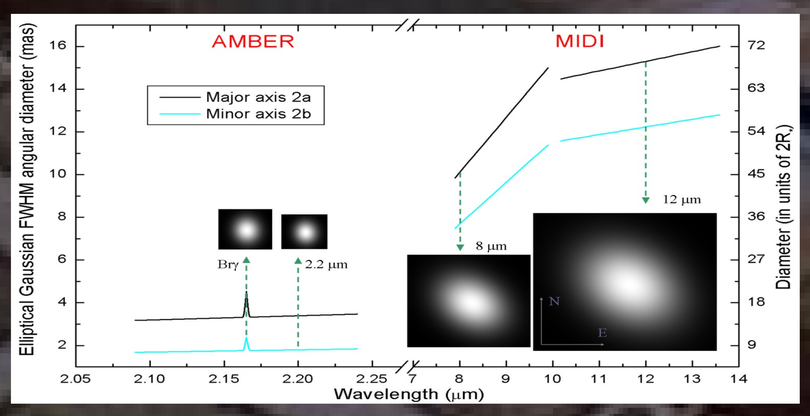
AMBER



Near-IR (JHK)
3 telescopes
Visibility, differential phase and phase closure
R=30, 1500, 12000
θ_{min}=2mas, beam=60mas

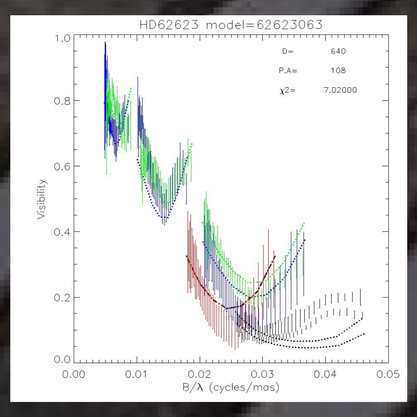
Our Sample

CPD-57^{0}2874: **B[e] supergiant. Based on MIDI and AMBER data, it was possible to see that the dust is distributed in a structure similar to an equatorial disk (Domiciano de Souza et al. 2007, A&A, 464, 81).**



GG Car: **B[e] supergiant in a binary system. From the modeling of visibilities from MIDI data, the presence of a dusty disk seen under an intermediate inclination angle (50^0 – 60^0) and assuming a distance of around of 1 kpc, seems to be confirmed (Carciofi et al., in preparation).**

HD 62623: **A[e] supergiant (maybe in a binary system). The presence of a dusty stratified disk is confirmed by the analysis of MIDI data (Meilland et al., in preparation).**



Orientation

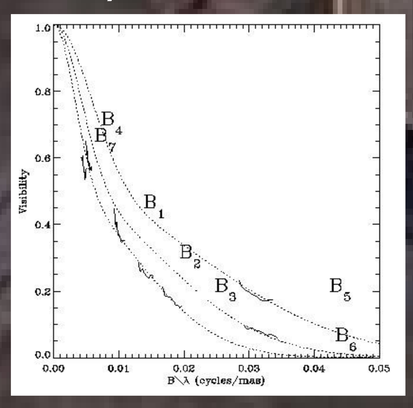
Blue ~ 45^0

Green ~ 84^0

Red ~ 27^0

HD 50138: **unclassified B[e] star (please see poster 338). Data from 17 baselines using MIDI and also from KECK segment-tilting experiment (Monnier et al. 2009, ApJ, 700, 491) are under analysis (Borges Fernandes et al., in preparation).**

HD 45677: **unclassified B[e] star. Monnier et al. (2006, ApJ, 647, 444) modeled IOTA data, assuming a skewed elliptical disk, due to the presence of a large nonzero closure phase. MIDI visibilities show the presence a strong silicate band, which can be modeled assuming an elliptical gaussian disk (Kanaan et al., in preparation).**



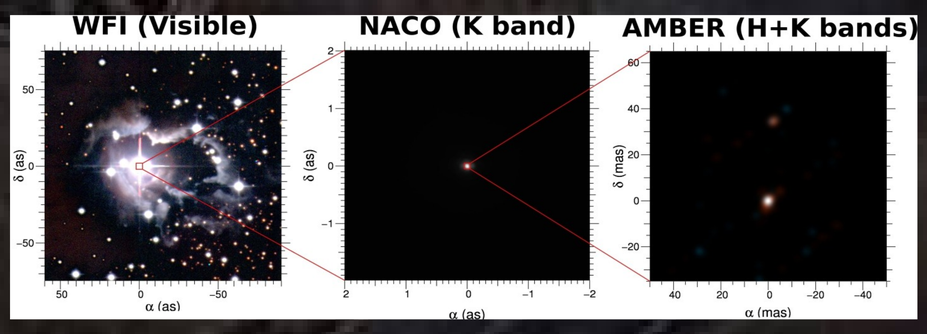
Elliptical Gaussian Disk:

FWHM$_{major\ axis}$ = 120 mas

FWHM$_{major\ axis}$ = 30 mas

MWC 361: **close-binary system with a young B[e] star that has a resolved disk, as one of the components. We have detected fringes using VEGA. This will allow us to study the characteristics of the Hα emitting-region (Borges Fernandes et al., in preparation).**

HD 87643: **unclassified B[e] star with a very complex circumstellar medium. A multi-wavelength campaign, including interferometry (MIDI and AMBER), spectroscopy (FEROS) and imaging (WFI and NACO) was made. The structure of the complex circumstellar environment was analyzed and a distance of 1.5 kpc was determined for this object. From the image reconstruction of AMBER data was possible to discover the presence of a companion, separated by 34 mas (Millour et al. 2009, A&A, accepted).**



Interferometry is the ideal tool to provide information concerning the geometry and inclination of the circumstellar matter of stars with the B[e] phenomenon. These results will certainly contribute for, in a near future, (i) the comprehension of the nature of some unclassified B[e] stars, and (ii) the inclusion of the B[e] phenomenon in the evolutionary tracks, especially confirming or not a possible link between B[e] supergiants and LBV, like Eta Car.